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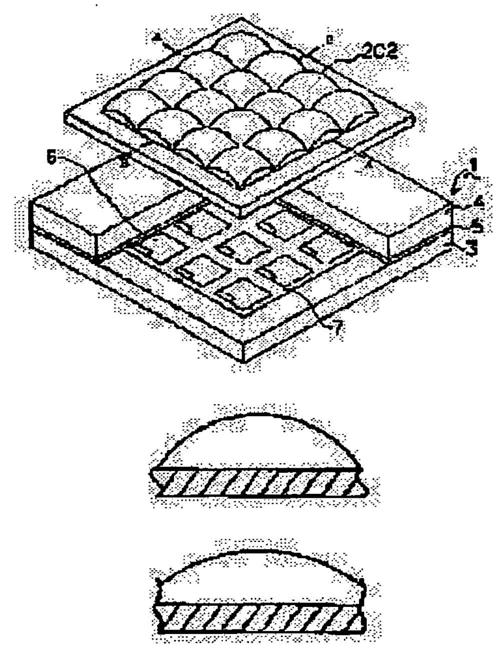
(54) IMAGE DISPLAY DEVICE

(57)Abstract:



PURPOSE: To suppress the increase of areas not to contribute to images, and to improve the quality of images by making the condensed spot shape of a microlens asymmetrical.

CONSTITUTION: This device is provided with a liquid crystal panel 1 equipped with a picture element group for which the opening shape of picture elements 6 is rectangular, and microlens array 202 to condense light from a light source to the openings of the picture elements 6 on the liquid crystal panel 1. Then, for the microlens array 202, the curvature of a lens on the end face of a line A-A is made different from the curvature of the lens on the end face of a line B-B. Namely, a focal distance corresponding to the short side direction of the rectangular opening is made different from the focal distance corresponding to the long side direction. By mounting the microlens array 202 using the microlens having such a focal distance on the liquid crystal panel 1, the shape of the condensed spot can be made equal to the opening shape of the liquid crystal panel 1. Thus, the areas not, contributing for images are decreased, and the reduction of picture quality can be suppressed.

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CLAIMS

[Claim(s)]
[Claim 1] It is the image display device characterized by to be constituted so that the focal distance corresponding to the direction of a shorter side of abbreviation rectangle opening of the above in the above-mentioned micro-lens array may differ from the focal distance corresponding to the direction of a long side in the image display device equipped with the light source, the liquid crystal panel which has the pixel group whose opening configuration of each pixel is an abbreviation rectangle-like, and the micro-lens array which makes opening of each pixel of the above-mentioned liquid crystal panel condense the light from the above-mentioned light source.
[Claim 2] It is the image display device characterized by to be constituted so that the above-mentioned micro-lens array may form a pattern condensing [short / long in the direction of a long side] in the direction of a shorter side of opening in the abbreviation rectangle opening location of the above in the image display device equipped with the light source, the liquid crystal panel which has the pixel group whose opening configuration of each pixel is an abbreviation rectangle-like, and the micro-lens array which makes opening of each pixel of the above-mentioned liquid crystal panel condense the light from the above-mentioned light source.
[Claim 3] In the image display device equipped with the light source, the liquid crystal panel which has a pixel group, the condensing optical system which condenses the light from the above-mentioned light source, and the micro-lens array which makes each pixel of the above-mentioned liquid crystal panel condense the light condensed by the above-mentioned condensing optical system Distance can be kept on the optical axis of L1 and the above-mentioned condensing optical system from the location of a condensing point and the pixel of the above-mentioned liquid crystal panel. [on the optical axis of the above-mentioned condensing optical system] [by condensing optical system] The image display device characterized by filling the relation of lambda2/lambda1=L2/L1 when the pitch of lambda 1 and the above-mentioned micro-lens array is set [the distance of the location of a condensing point and the above-mentioned micro-lens array by condensing optical system] to lambda 2 for the pitch of the pixel of L2 and the above-mentioned liquid crystal panel.
[Claim 4] The above-mentioned micro-lens array is an image display device characterized by arranging the lens configuration side towards the above-mentioned liquid crystal panel in the image display device equipped with the light source, the liquid crystal panel which has a pixel group, and the micro-lens array which makes each pixel of the above-mentioned liquid crystal panel condense the light from the above-mentioned light source.
[Claim 5] The image display device according to claim 4 characterized by having formed the spacer in the periphery of the above-mentioned micro-lens array, and having arranged the above-mentioned micro-lens array to the above-mentioned liquid crystal panel through this spacer.
[Claim 6] The image display device according to claim 4 or 5 characterized by filling up with the ingredient with a refractive index smaller than the refractive index of the ingredient which forms the lens array between the above-mentioned micro-lens array and a liquid crystal panel.
[Claim 7] The image display device according to claim 1, 2, 3, 4, or 5 characterized by forming the optical-path conversion pattern which changes the optical path of the light which carries out

incidence for performing alignment to the lens array periphery of the above-mentioned micro-lens array.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the image display device which comes to load a micro-lens array in this panel for the purpose of a raise in the brightness of the projection screen by the liquid crystal display panel.
[0002]
[Description of the Prior Art] The conventional image display device which loaded the micro-lens array in this liquid crystal display panel for the purpose of the raise in the brightness of a liquid crystal display panel is explained with reference to drawing 1 . The liquid crystal display panel (henceforth a liquid crystal panel) 1 consists of a TFT transparence substrate 3 with which TFT (thin film transistor)11 was formed, a transparence substrate 4 which counters this, and liquid crystal 5. And the micro-lens array 2 is loaded in this liquid crystal panel 1. Two or more electrodes 6 are arranged in line at the TFT transparence substrate 3. This electrode 6 is transparence so that light may penetrate, and below, it also calls this electrode 6 opening of a liquid crystal panel 1. This opening has become abbreviation rectangle-like corresponding to the configuration of a pixel.
[0003] The configuration of a liquid crystal panel 1 is shown in drawing 2 , drawing 3 , and drawing 4 . On the TFT transparence substrate 3, a transparent electrode 6, the gate 24, an insulator layer 27, TFT11, the source 22, and a drain 23 are formed. Moreover, liquid crystal 5 is inserted and the insulator layer 29 and the counterelectrode 20 are formed in the transparence substrate 4 side which counters. Drawing 5 is drawing when seeing the opening 6 of a liquid crystal panel 1, and wiring 7 under a microscope. Drawing 6 shows the pattern (white section) of the light which penetrated the opening 6 of a liquid crystal panel 1. Drawing 7 shows the optical system of a liquid crystal projector. It is reflected with a reflecting mirror 32, the light which came out of the light source 31 is condensed with the condensing lens 33 on an optical axis L, and image formation projection of the light which penetrated the liquid crystal panel 1 equipped with the micro-lens array 2 is carried out on a screen 38 with the projection lens 37. Polarizing plates 35 and 36 are arranged before and behind the liquid crystal panel 1.
[0004] Next, drawing 8 and drawing 9 explain the image display at the time of loading with the case where the micro-lens array 2 is not loaded in a liquid crystal panel 1. As shown in drawing 8 R> 8 (a), incident light penetrates only the part of the opening 6 of a liquid crystal panel 1, and when not loading, as shown in drawing 9 (a), the amplification projection image of the opening pattern which carried out the shape of an abbreviation rectangle of a liquid crystal panel 1 is formed on a screen 38 with the projection lens 37. On the other hand, as shown in drawing 8 (b), incident light is condensed by the micro-lens array 2 in opening 6 location of a liquid crystal panel 1, a condensing spot is formed, a liquid crystal panel 1 is penetrated, and when the micro-lens array 2 is loaded in a liquid crystal panel 1, as shown on a screen 38 at drawing 9 R> 9 (b), amplification projection of the condensing spot is carried out with the projection lens 37. Since the curvature of the micro lens of the micro-lens array 2 has isotropy, it becomes circular [the configuration of a condensing spot].
[0005] By the way, in order to realize effectively the high brightness of a liquid crystal panel, and

efficient-ization, it is necessary to make this condensing spot configuration below into the opening configuration (shorter side length of opening) of a liquid crystal panel. At this time, an opening configuration becomes a condensing spot configuration and equivalence. Therefore, the configuration of the opening pattern (condensing spot pattern) projected on a screen becomes small as compared with the case where a micro-lens array is not loaded in a liquid crystal panel. For this reason, the field which does not contribute to an image increases, the quality of an image deteriorates, and ZARATSUKI arises in an image. As an example which solves the above-mentioned trouble, it is possible to carry out a condensing spot configuration beyond an opening configuration. However, for a KERARE ** reason, effectiveness falls [a condensing spot] to opening to efficient-izing of a liquid crystal panel.
[0006] Moreover, the micro-lens array is loaded in the light source side of a liquid crystal panel for the purpose of the raise in the brightness of a projection screen. Here, the pitch of the micro-lens array 2 is set up equally to the pitch of a liquid crystal panel 1. However, since the location of the opening 6 of a micro lens and a liquid crystal panel 1 shifted as it separates from the optical axis L of a liquid crystal projector in the conventional configuration with equal pitch of the micro-lens array 2 and pitch of a liquid crystal panel 1, there was a trouble that the brightness of a screen fell. The principle of this screen intensity lowering is shown in drawing 17 . In order that the light condensed with the condensing lens 33 may carry out incidence to the micro-lens array 2, the light which carries out incidence to a micro lens brings an include angle to the optical axis L of a liquid crystal projector, so that it separates from the optical axis L of a liquid crystal projector. That is, the optical axis of each micro lens will turn to the direction of the focus F of a condensing lens 33. Therefore, since the condensing spot of each micro lens is formed on each optical axis, the light condensed by the micro lens will not pass the opening 6 of a liquid crystal panel 1, and has the problem that the brightness of a screen falls.
[0007] Moreover, in the image display device as shown in drawing 1 , that in which the micro-lens array 2 generally has two-dimensional curvature structure is used. When it mounts such a micro-lens array 2 in a liquid crystal panel 1, there is the approach of carrying out adhesion immobilization of the flat side of the rear face of a substrate and the flat side of the transparence substrate 4 of a liquid crystal panel 1 in which the micro-lens array 2 was formed. According to this approach, since the flat side was doubled mutually and it has pasted up, the whole surface can be filled up with the resin for adhesion, and there is an advantage that bond strength is high. On the other hand, the greatest object which loads the micro-lens array 2 in a liquid crystal panel 1 is in efficient-ization of a liquid crystal panel 1. The principle of efficient-izing of a liquid crystal panel 1 is shown in drawing 20 . The conventional example which is not is shown, and a lens forming face is the example of this invention which (b) mentions later closely, and, as for (a) of drawing 20 , shows the case where a lens forming face is close to an effective area to an effective area. In the former of this drawing (a), the thickness of the micro-lens array 2 will be distributed by the time the light which passed 0.7 micrometers and the micro lens 102 whose thickness of a substrate 8 is one of those with 1.1mm and the micro-lens arrays 2 reaches the opening 6 of a liquid crystal panel 1, and luminous intensity can weaken. The optical path of the forming face of the micro-lens array 2 and the effective area of a liquid crystal panel 1 is in the location from which only the thickness of the substrate with which the micro-lens array 2 was constituted was separated, and effectiveness over efficient-izing of a liquid crystal panel 1 cannot be desired.
[0008] Moreover, in a liquid crystal panel which was mentioned above, the alignment of the TFT transparence substrate 3 and the opposite substrate 4 detects relative-position gap of the alignment mark formed in the predetermined location on each substrate using an image processing, and is performed by correcting this gap. The alignment precision at this time is about several micrometers. In order to raise the recognition property as an image, it is optically opaque to an alignment mark, and inorganic materials, such as Cr with easy production, are used for it by the panel production process line. The outline procedure of this alignment is shown in drawing 32 , and adjustment is completed because both alignment marks overlap on an image.
[0009] Drawing 33 shows the replica structure of the micro-lens array 2 produced using 2P law. As for the alignment precision of the micro-lens array 2 and a liquid crystal panel 1, the

alignment precision and equivalent level (about several micrometers) of the TFT transparence substrate 3 of the above-mentioned liquid crystal panel 1 and the opposite substrate 4 are required. As an approach of mounting the micro-lens array 2 and a liquid crystal panel 1 in high degree of accuracy, the alignment approach of the liquid crystal panel 1 using an above-mentioned image processing and the same approach can be considered. As an alignment method of a micro lens using this approach, the following processes as shown in drawing 34 can be considered.

[0010] As shown in drawing 34 (a), first, like the case of a liquid crystal panel 1, on the transparence substrate 8, Cr etc. is used and the alignment mark 73 is formed. Next, as shown in drawing 34 (b), alignment of the alignment mark 73 on the transparence substrate 8 and the alignment mark on La Stampa 71 is performed. Next, a photo-setting resin is applied on the transparence substrate 8, and hardening formation of the lens pattern is carried out. Next, as shown in drawing 34 R> 4 (c), alignment with a liquid crystal panel 1 is performed using the alignment mark 73 on the transparence substrate 8.

[0011] However, there are the three following troubles in an alignment process as shown in drawing 34 . ** In order to set alignment precision of the micro-lens array 2 and a liquid crystal panel 1 to about several micrometers, it is necessary to make alignment precision of La Stampa 71 and a glass substrate 8 into submicron extent, and implementability is missing. ** Opaque nickel with comparable Cr and light reflex reinforcement of La Stampa 71 material is optically in use. Therefore, it is dramatically difficult to be unable to take contrast of an image but to perform alignment of La Stampa 71 and a glass substrate 8. ** Since the alignment process of a glass substrate 8 and La Stampa 71 is added, the total cost of a liquid crystal panel 1 newly goes up.

[0012]

[Problem(s) to be Solved by the Invention] The 1st object is shown in a liquid crystal panel and the image display device which used the micro-lens array, it is giving asymmetry to the condensing spot configuration of a micro lens, the increment in the field which does not contribute to an image can be reduced [this invention was made paying attention to the conventional trouble which was mentioned above,], and it is in raising the quality of an image. The 2nd object is for the light condensed by the micro lens to come to pass opening of a liquid crystal panel, and make it the brightness of a screen not fall by making in agreement the optical axis of a rear-spring-supporter micro lens, and the optical axis of liquid crystal panel opening all over a liquid crystal panel. The 3rd object is shown in attaining efficient-ization of a liquid crystal panel by turning a micro-lens array forming face to a liquid crystal panel side, making it the configuration which can be mounted, and making light condense efficiently to the pixel of a liquid crystal panel. In the alignment process of a micro-lens array and a liquid crystal panel, the 4th object is removing the alignment process of La Stampa and a glass substrate, and it is shown in aiming at a cost cut, pressing down lowering of alignment precision.

[0013]

[Means for Solving the Problem] In order to attain the above-mentioned object invention of claim 1 In the image display device equipped with the light source, the liquid crystal panel which has the pixel group whose opening configuration of each pixel is an abbreviation rectangle-like, and the micro-lens array which makes opening of each pixel of the above-mentioned liquid crystal panel condense the light from the above-mentioned light source The above-mentioned micro-lens array is constituted so that the focal distance corresponding to the direction of a shorter side of abbreviation rectangle opening of the above may differ from the focal distance corresponding to the direction of a long side. Invention of claim 2 is constituted so that the above-mentioned micro-lens array may form a pattern condensing [short / long in the direction of a long side] in the direction of a shorter side of opening in the abbreviation rectangle opening location of the above. Invention of claim 3 can keep distance on the optical axis of L1 and the above-mentioned condensing optical system from the location of a condensing point and the pixel of the above-mentioned liquid crystal panel. [on the optical axis of the above-mentioned condensing optical system] [by condensing optical system] When the pitch of lambda 1 and the above-mentioned micro-lens array is set [the distance of the location of a condensing point

and the above-mentioned micro-lens array by condensing optical system] to lambda 2 for the pitch of the pixel of L2 and the above-mentioned liquid crystal panel, the relation of lambda2/lambda1=L2/L1 is filled. As for invention of claim 4, the lens configuration side is arranged towards the above-mentioned liquid crystal panel in the above-mentioned micro-lens array. A spacer is formed in the periphery of the above-mentioned micro-lens array, and invention of claim 5 arranges the above-mentioned micro-lens array to the above-mentioned liquid crystal panel through this spacer. It fills up with the ingredient with a refractive index smaller than the refractive index of the ingredient with which invention of claim 6 forms the lens array between the above-mentioned micro-lens array and a liquid crystal panel. The optical-path conversion pattern which changes the optical path of the light which carries out incidence for invention of claim 7 to perform alignment to the lens array periphery of the above-mentioned micro-lens array is formed.

[0014]

[Function] According to the above-mentioned configuration, since the condensing spot of a micro-lens array can penetrate opening of a liquid crystal panel, high brightness-ization of a liquid crystal panel is realizable. Furthermore, lowering of alignment precision can be pressed down, the process of alignment can be simplified, and low cost-ization of a liquid crystal panel can be attained.

[0015]

[Example] The optical system which loaded the micro-lens array 202 with the asymmetry of curvature by the 1st example of this invention in the liquid crystal panel 1 is shown in drawing 10 . This example corresponds to invention of claims 1 and 2. This drawing (b) shows the A-A line cross section of this drawing (a), and (c) shows the B-B line cross section of this drawing (a). Like a graphic display, the micro-lens array 202 is considered as the configuration from which the lens curvature in an A-A line cross section and the lens curvature in a B-B line cross section differed. The example of a design of the micro-lens array 2 is explained with reference to drawing 11 . Now, it asks for synthetic focal distance l' of a condensing lens 33 and a micro lens. If principal plane spacing of f, a condensing lens 33, and a micro lens is set [the focal distance of a condensing lens 33] to l for the focal distance of Fc and a micro lens, synthetic focal distance l' of a condensing lens 33 and a micro lens will be called for in the following formulas.

[0016]

[Equation 1]

$$\frac{1}{l'}=\frac{1}{Fc-l}+\frac{1}{f}=\frac{Fc+f-l}{f\,(Fc-l)}$$

$$l'=\frac{f\,(Fc-l)}{Fc+f-l}$$

ここでFc>>f，lとすると、

$$l'=\frac{f\left(1-\frac{l}{Fc}\right)}{1+\frac{f}{Fc}-\frac{l}{Fc}}\fallingdotseq f$$

[0017] As mentioned above, it turns out that what is necessary is just to deal with synthetic focal distance l' of a condensing lens 33 and a micro lens as the focal distance f and equal of a micro lens in approximation. As an example actually used, Fc=160mm, l= 10mm, and f = 0 or 5mm are raised.

[0018] Drawing 12 shows the diameter of image formation of the light source by the micro lens. The image of the light source and the light source 31 in which image formation is carried out by the micro lens is connected to the collimation mold through the reflecting mirror 32 and the micro lens. axb (a: a shorter side, b:long side) and the diameter of opening of a micro lens are made [the distance which met the optical axis L from D and the light source 31 to the principal plane of a reflecting mirror 32 in light source 31 path / the synthetic focal distance of Fr, a

condensing lens 33, and a micro lens] into cxd for f and the diameter of opening of a liquid crystal panel. The diameter W of a condensing spot in case the curvature of a micro lens has isotropy serves as W=Dxf/Fr.

[0019] Here, the focal distance of the micro lens in W>a is shown first, referring to drawing 13 , drawing 15 , and drawing 16 . Here, the focal distance of the x directions of [at the time of making an axis of coordinates correspond] and the direction of y is expressed to the optical path from the principal plane of a micro lens to the opening 6 of a liquid crystal panel 1, and the micro lens in which la has fx and fy has biaxial symmetric property, respectively. Augend deltaWx of the diameter of a condensing spot of the x directions in the focal location of the direction of y becomes deltaWx=d/fxx (fx-fy). What is necessary is just to consider as deltaWx=b-W, in order to make the diameter of a condensing spot of x directions equal to x lay length b of opening 6 at this time. Therefore, the focal distance fx of a micro lens serves as fx=d/(d-b+W) xfyfy=la.

[0020] Next, the focal distance of the micro lens in W<a is shown, referring to drawing 14 , drawing 15 , and drawing 16 . Augend deltaWy of the diameter of a condensing spot at the time of focal distance fy' (!=la) of the direction of y becomes deltaWy=c/fy'x (fy'-la). What is necessary is just to consider as deltaWy=a-W, in order to make the diameter of a condensing spot of the direction of y equal to y lay length a of opening 6 at this time. Therefore, focal distance fy' becomes fy'=cxla/(c-a+W). Moreover, in order to make the diameter of a condensing spot of x directions equal to the x directions of the diameter of opening at this time, focal distance fy' of a micro lens is fy'=cxla/(c-a+W) from two formulas of deltaWx=d/fx'x (fx'-fy') and deltaWx=b-a.

It becomes fx'=d/(d+a-b) xfy'. In addition, this example has calculated, having assumed that the pixel configuration of a liquid crystal panel 1 and the opening configuration of the micro-lens array 2 were equal.

[0021] Since the configuration of the condensing spot of the micro-lens array 202 can be made almost equal to the opening configuration of a liquid crystal panel 1 by loading the micro-lens array 202 using the micro lens of the above focal distances in a liquid crystal panel 1, the opening pattern of the liquid crystal panel 1 projected on the screen at the time of loading the micro-lens array 202 is made the shape of an opening pattern and isomorphism when not loading the micro-lens array 202 in a liquid crystal panel 1. The field which does not contribute to an image decreases by this, and deterioration of image quality can be suppressed. In addition, openings of a micro lens are a rectangle, circular, an ellipse form, etc., and the focal distance should just change with a long side and directions of a shorter side. That by which the opening of a lens itself is condensed by the shape of an ellipse while the optical spot has been an ellipse-like can be considered. Moreover, whichever is sufficient as the sense which loads the micro-lens array 2 in a liquid crystal panel 1.

[0022] Next, the 2nd example is explained with reference to drawing 18 . This example makes in agreement the optical axis of a rear-spring-supporter micro lens, and the optical axis of liquid crystal opening all over a liquid crystal panel. The optical path from the forming face of opening 6 location of a liquid crystal panel 1 and the micro-lens array 52 to the focus F of a condensing lens 33 is set to L1 and L2, respectively. Moreover, if the pitch of a liquid crystal panel 1 and the pitch of the micro-lens array 52 are set to lambda1 and lambda2, respectively, the opening 6 of a liquid crystal panel 1 can be made to penetrate all the condensing spots of a micro lens effectively by constituting so that the relation of lambda2/lambda1=L2/L1 may be satisfied. Thereby, rear-spring-supporter high brightness-ization is realizable throughout a projection screen. In addition, what kind of form is sufficient as opening of a lens, and a condensing spot, and whichever is sufficient as the sense which loads the micro-lens array 52 in a liquid crystal panel 1.

[0023] Next, the 3rd example of this invention is explained. The image formation optical system of a liquid crystal projector is shown in drawing 19 , and the principle of efficient-izing of a liquid crystal panel is shown in drawing 20 . As shown in this drawing (b), in this example, near of the lens forming face of the micro-lens array 2 is carried out to the effective area. In the case of this drawing 20 (b), compared with the configuration of conventional drawing 20 (a), it does not distribute and luminous intensity cannot weaken the light which passed the micro lens 102.

Therefore, it turns out that the diameter of a condensing spot becomes small and the direction with the field near the effective area of a liquid crystal panel 1 in which the micro-lens array 2 currently formed on the support substrate 8 is located is more advantageous to efficient-izing. So, as shown in drawing 21 , efficient-ization of a liquid crystal panel 1 can be attained by arranging the micro-lens array 2 so that the lens configuration side may face to a liquid crystal panel 1. In addition, what kind of form is sufficient as opening of a lens, and a condensing spot.
[0024] Here, the diameter of a condensing spot in the configuration of conventional drawing 20 (a) is explained using drawing 12 mentioned above. Substrate thickness of dp=1.1mm and the micro-lens array 2 is set [the diameter of the light source / the focal distance of D= 2mm and a reflecting mirror] to dm=1.1mm for Fr=13mm and the glass substrate thickness of a liquid crystal panel 1. Moreover, if the refractive index of a substrate is set to n= 1.5, the diameter W of a condensing spot in the effective area of a liquid crystal panel 1 will be set to W=Dx(dp+dm)/(Frxn)=225micrometer. Opening configuration axb=120x94micrometer2 of a liquid crystal panel 1 If it carries out, since the diameter of opening is large, effectiveness will not improve to W= 225 micrometers of diameters of a condensing spot. Although the thickness of the glass substrate of a liquid crystal panel 1 is in the inclination of thin-shape-izing in recent years, implementation of a thin substrate is difficult by the washing nonuniformity produced from the deflection of lowering of the flatness of the substrate produced from the difficulty of polish and handling in the manufacture process of a liquid crystal panel 1, and the substrate in the time of conveyance. Similarly, the substrate of the micro-lens array 2 is also considered from flatness, the difficulty of washing, and reinforcement, and the formation of a thin substrate is difficult also a substrate. As mentioned above, with the conventional configuration, it turns out that efficient-izing of a liquid crystal panel is difficult.
[0025] To it, by this invention, the above-mentioned problem is solved as structure which can be mounted so that the lens configuration side may face the micro-lens array 2 to a liquid crystal panel 1 as mentioned above. Hereafter, the example of a configuration of the spacing member at the time of using a spacing member is explained as this example of mounting. The example which formed the spacing member 61 between the liquid crystal panel 1 and the micro-lens array 2 is shown in drawing 22 R> 2. This spacing member 61 has a plate and frame structure, it is larger than the field in which the micro-lens array 2 is formed, and its bore of a frame is smaller than the outer diameter of the glass substrate of the liquid crystal panel 1 with which the outer diameter of a frame is mounted. Since the adhesion immobilization of the flat side of the glass substrate of a liquid crystal panel 1 and the flat side of the micro-lens array 2 can be carried out by doing in this way, bond strength can be made high. That by which the spacing member 61 is being fixed to the 8th page of the substrate of the micro-lens array 2 is shown in drawing 23 and drawing 24 .
[0026] The example from which at least one field of the frame structure of a spacing member 62 was cut is shown in drawing 25 . The liquid crystal panel is omitted in this drawing. Although the micro-lens array 2 is made by the air space in the configuration mounted in the liquid crystal panel 1 between a liquid crystal panel 1 and the forming face of the micro-lens array 2, since this air space becomes equal to atmospheric pressure by establishing a clearance in a spacing member 62 selectively as mentioned above, the camber of the substrate of the micro-lens array 2 accompanying external pressure change can be abolished.
[0027] How to produce the duplicate of the micro-lens array 2 which formed the spacing member 61 using La Stampa is shown in drawing 26 . This producing method makes La Stampa 71 material deposit from on (a) by making into original recording the micro-lens array 2 which formed the spacing member 61, and produces (b) and La Stampa 71 (c). The vertical inversion of this La Stampa 71 is carried out, melting resin 72 is poured in from a top, and the support substrate 8 is carried further (d). A replica is produced by the above approach (e). Since a spacing member 61 can produce the micro-lens array 2 formed on the substrate 8 at one by carrying out like this, laborsaving of the alignment process at the time of mounting and low cost-ization by reduction of components mark can be attained.
[0028] The example which prepared at least two or more frames of a spacing member 61 in the flat surface of a substrate 8 is shown in drawing 27 . carrying out like this — 2-P — when

reproducing using law, that of the resin to the outside of a substrate can be seen, and can prevent a broth effectively. that is, when a micro-lens side is turned upwards and it is filled up with melting resin 72 between La Stampa 71 and the support substrate 8 like drawing 28 (a) which shows the method of being filled up with melting resin, melting resin 72 is **** -- although there is ********, since there are two or more slots when a micro-lens side is turned downward and it is filled up with melting resin 72 like drawing 28 (b), that of melting resin 72 can be seen and can prevent a broth.

[0029] Next, the mounting process using the above spacing members is explained. As shown in drawing 24 mentioned above, the flat side of the glass substrate of a liquid crystal panel 1 and the flat side of the substrate 8 of the micro-lens array 2 fill up with hardenability resin the clearance formed among both in the configuration which left by the thickness of a spacing member 61 and was pasted up through the spacing member 61. Since a flat side can be mutually pasted up by carrying out like this, bond strength can be made high. At this time, a spacing member 61 prevents osmosis in the lens forming face of hardenability resin, the yield is good and mounting of it is attained.

[0030] As temporary immobilization of mounting, as a photo-setting resin 74 and this immobilization, in the mounting configuration shown in drawing 29 , a liquid crystal panel 1 and the micro-lens array 2 are pasted up using epoxy system hardenability resin 75 so that the top face of a photo-setting resin 74 may be covered. Although the setting time of a photo-setting resin 74 is short, its bond strength is relatively weak as compared with other hardenability resin. On the other hand, bond strength is strong although the setting time of epoxy system hardenability resin 75 is long. Then, since both advantage can be positively used by using a photo-setting resin 74 for temporary immobilization, and using epoxy system hardenability resin 75 for this immobilization, adhesion mounting by which the setting time was short stabilized also in reinforcement is realizable.

[0031] Next, the operation at the time of being filled up with a filler between a liquid crystal panel 1 and the micro-lens array 2 is explained using drawing 30 and drawing 31 . It is filled up with the ingredient 74 with a refractive index smaller than the refractive index of the ingredient which forms the micro-lens array 2 between a liquid crystal panel 1 and the micro-lens array 2. In this case, it is good even if a spacing member 61 is between a liquid crystal panel 1 and the micro-lens array 2 (in the case of drawing 31), and there is nothing (in the case of drawing 30). Thus, a spacing member 61 is not necessarily required, and the direction sprinkled as a binder in order to function as resin for adhesion at the time of mounting, if filled up with a filler as mentioned above is easier for it than the case where it carries out with ** to a perimeter, and its reinforcement is also strong. Moreover, the camber of the lens by the atmospheric-pressure difference and a liquid crystal substrate can be prevented by filling up with resin. The reason for being filled up with the ingredient 74 with a low refractive index is that it does not have a condensing function, if a surrounding refractive index is not smaller than a lens refractive index when a lens configuration is a convex.

[0032] The 4th example of this invention is explained. Drawing 35 shows the configuration of the micro-lens array 2. The optical-path sensing element 80 with the function to change the travelling direction of light is formed in the location corresponding to the alignment mark of a liquid crystal panel 1 on a glass substrate 8 at the time of original recording production. The optical-path sensing element 80 is produced like production of the micro-lens array 2 mentioned above using a semi-conductor production process, as shown in drawing 36 . Therefore, the relative position of the optical-path sensing element 80 and the micro-lens array 2 will become exact, so that it has the precision below submicron one.

[0033] An alignment process principle is shown in drawing 37 and drawing 38 . The camera 90 which measures the quantity of light is formed above the micro-lens array 2. As for the light illuminated by the optical-path sensing element 80, the travelling direction changes. Since the quantity of lights incorporated by the camera 90 will differ in the optical-path sensing element 80 and its perimeter and the contrast as an image will be acquired by this, alignment of the image of this optical-path sensing element 80 and the image of the alignment mark of a liquid crystal panel 1 can be performed easily.

[0034] Thus, since the alignment precision of the optical-path sensing element 80 (alignment mark) and the micro-lens array 2 is realizable by below submicron one by forming the optical-path sensing element 80, it can mount, without reducing the alignment precision of a liquid crystal panel 1 and the micro-lens array 2 as a result. Moreover, since the optical-path sensing element 80 (alignment mark) and the micro-lens array 2 are produced simultaneously, an alignment process is simplified and low-cost-izing of a liquid crystal panel 1 and the improvement in the yield are attained.

[0035]

[Effect of the Invention] Since the condensing spot configuration of a micro-lens array can be made almost equal to the opening configuration of a liquid crystal panel as mentioned above according to invention of claims 1 and 2, the increment in the field which does not contribute to an image can be reduced, and deterioration of image quality, such as ZARATSUKI of an image, can be lost as a result. So, raise in the brightness of a liquid crystal panel and efficient-ization can be realized more effectively. According to invention of claim 3, since all the condensing spots of a micro-lens array can penetrate opening of a liquid crystal panel, high brightness-ization is realizable over the screen whole region. According to claim 4 thru/or invention of 6, since a micro-lens array forming face is close to a liquid crystal panel effective area, light can be made to condense efficiently to the pixel of a liquid crystal panel, and efficient-ization of a liquid crystal panel can be attained. Since an alignment process is simplified according to invention of claim 7, without reducing alignment precision, cost cut of a liquid crystal panel and improvement in the yield can be aimed at.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] They are the conventional liquid crystal panel and the perspective view of a micro-lens array.
[Drawing 2] It is the top view of the transparence substrate of a liquid crystal panel.
[Drawing 3] It is the top view of a transparent electrode.
[Drawing 4] It is the A-A line sectional view of drawing 2 .
[Drawing 5] It is drawing seen under the microscope in which opening of a liquid crystal panel and wiring are shown.
[Drawing 6] It is drawing showing the pattern of the opening transmitted light of a liquid crystal panel.
[Drawing 7] It is drawing showing the optical system of a liquid crystal projector.
[Drawing 8] In drawing showing optical system, (a) shows the case where (b) loads a micro-lens array in a liquid crystal panel, when the micro-lens array is not being loaded in a liquid crystal panel.
[Drawing 9] In drawing showing the opening extended pattern on a screen, (a) shows the case where (b) loads a micro-lens array in a liquid crystal panel, when the micro-lens array is not being loaded in a liquid crystal panel.
[Drawing 10] It is drawing showing the liquid crystal panel about the 1st example of this invention, and a micro-lens array, and (a) is [an A-A line sectional view and (c of a perspective view and (b))] B-B line sectional views.
[Drawing 11] It is drawing for drawing the synthetic focal distance of a condensing lens and a micro lens.
[Drawing 12] It is drawing for drawing the diameter of the light source by the micro lens.
[Drawing 13] It is drawing showing the relation between a condensing spot and the diameter of opening of a liquid crystal panel.
[Drawing 14] It is drawing showing the relation between a condensing spot and the diameter of opening of a liquid crystal panel.
[Drawing 15] It is drawing showing the condensing property in the case of having asymmetry in a focal distance.
[Drawing 16] In drawing showing the condensing property in the case of having asymmetry in a focal distance, (a) shows x directions and (b) shows the condensing condition of the direction of y.
[Drawing 17] It is drawing explaining the principle of the conventional screen intensity lowering.
[Drawing 18] It is drawing showing the liquid crystal panel about the 2nd example of this invention, and a micro-lens array.
[Drawing 19] It is drawing showing the image formation optical system of a liquid crystal projector.
[Drawing 20] In drawing explaining the principle of efficient-izing of a liquid crystal panel, (a) shows the conventional example and (b) shows the 3rd example of this invention.
[Drawing 21] It is drawing showing arrangement of the micro-lens array in the 3rd example of the above, and (a) is a perspective view and (b) is the B-B line sectional view of (a).

[Drawing 22] In the 3rd example, they are a liquid crystal panel in the case of using a spacer, and the perspective view of a micro-lens array.
[Drawing 23] It is the perspective view of the micro-lens array in the case of using a spacer.
[Drawing 24] They are a liquid crystal panel in the case of using a spacer, and the perspective view of a micro-lens array.
[Drawing 25] It is the perspective view of the micro-lens array by the deformation example.
[Drawing 26] It is drawing explaining the method of producing a micro-lens array.
[Drawing 27] It is the perspective view showing the modification of a micro-lens array.
[Drawing 28] It is drawing showing the restoration approach of melting resin.
[Drawing 29] It is drawing showing other examples of the adhesion configuration of a micro-lens array and a liquid crystal panel.
[Drawing 30] It is the sectional side elevation showing the condition of having been filled up with the filler between the liquid crystal panel and the micro-lens array.
[Drawing 31] It is the sectional side elevation showing the condition of having been filled up with the filler between the liquid crystal panel and the micro-lens array using the spacer.
[Drawing 32] It is the flow chart which shows the process of the alignment of each glass substrate of the conventional liquid crystal panel.
[Drawing 33] It is the perspective view of a micro-lens array.
[Drawing 34] It is drawing explaining the alignment of a micro-lens array.
[Drawing 35] It is the perspective view of the micro-lens array in the 4th example of this invention.
[Drawing 36] It is drawing explaining the production process of a micro-lens array.
[Drawing 37] It is a perspective view for explaining the alignment of the micro-lens array in the above-mentioned example.
[Drawing 38] It is a sectional side elevation for explaining the alignment of the micro-lens array in the above-mentioned example.
[Description of Notations]
1 Liquid Crystal Panel
2 52,202 Micro-lens array
6 Pixel Electrode (Opening)
31 Light Source
61 62 Spacing member
74 Member with Low Refractive Index
80 Optical-Path Sensing Element

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(54)【発明の名称】　画像表示装置

(57)【要約】

【目的】　液晶パネルとマイクロレンズアレイを用いた画像表示装置にあって、画像のザラツキ等の画質の低下を抑え、液晶パネルの高輝度化、高効率化を実現することを目的とする。

【構成】　曲率の非対称性を持つマイクロレンズアレイ２０２を液晶パネル１に装荷することにより、マイクロレンズアレイ２０２の集光スポットの形状を液晶パネル１の開口６の形状とほぼ等しくすることができる。このため、画像に寄与しない領域が少なくなり、画質の低下を抑えることができ、液晶パネル１による投影画像の高輝度化が図れる。